MEMORANDUM TO E.C.W. TECHNICIANS
on the
DESIGN AND CONTROL OF BROAD, SHALLOW TERRACE OUTLET DITCHES

Emergency Conservation Erosion Camps

October 10, 1934.

The purpose of this memorandum is to make a few suggestions that may be helpful in designing terrace outlet ditches and developing the vegetative control phase of the work in E.C.W. erosion camps.

Conditions encountered are so variable that it is not possible to make definite recommendations which will apply on every project. Variables in climate and soil, desires of land owners respecting certain grasses and grasses available locally are the considerations by which each camp must be guided in this work. Even within a single camp area these variations will make uniform treatment of all projects impractical.

Channel Design.

The channel must be designed with a broad, level bottom so that it will have a shallow flow of uniform depth over the entire bottom. Side slopes should be about 1-1/2 to 1. In this design the Chezy formula $V = C\sqrt{rs}$, and the Kutter formula

$$C = \frac{41.6 + \frac{1.811}{n} + \frac{0.00281}{s}}{1 + \left(41.6 + \frac{0.00281}{s}\right)\frac{n}{\sqrt{r}}}$$

are used.

Where V = velocity in feet per second
C = a coefficient of resistance to flow, influenced by hydraulic elements;

r = hydraulic radius = $\frac{\text{cross-sectional area}}{\text{wetted perimeter}}$

s = tangent of angle of grade = $\frac{\text{fall (ft.)}}{\text{channel length (ft.)}}$

n = coefficient of roughness = 0.040

In this design the average grade cannot be used unless the grade of the entire channel is uniform. Each section having a grade different from other sections should be designed separately. Figures 1A, 1B and 1C are included to show channel widths and depths required for different grades and different rates of run-off.

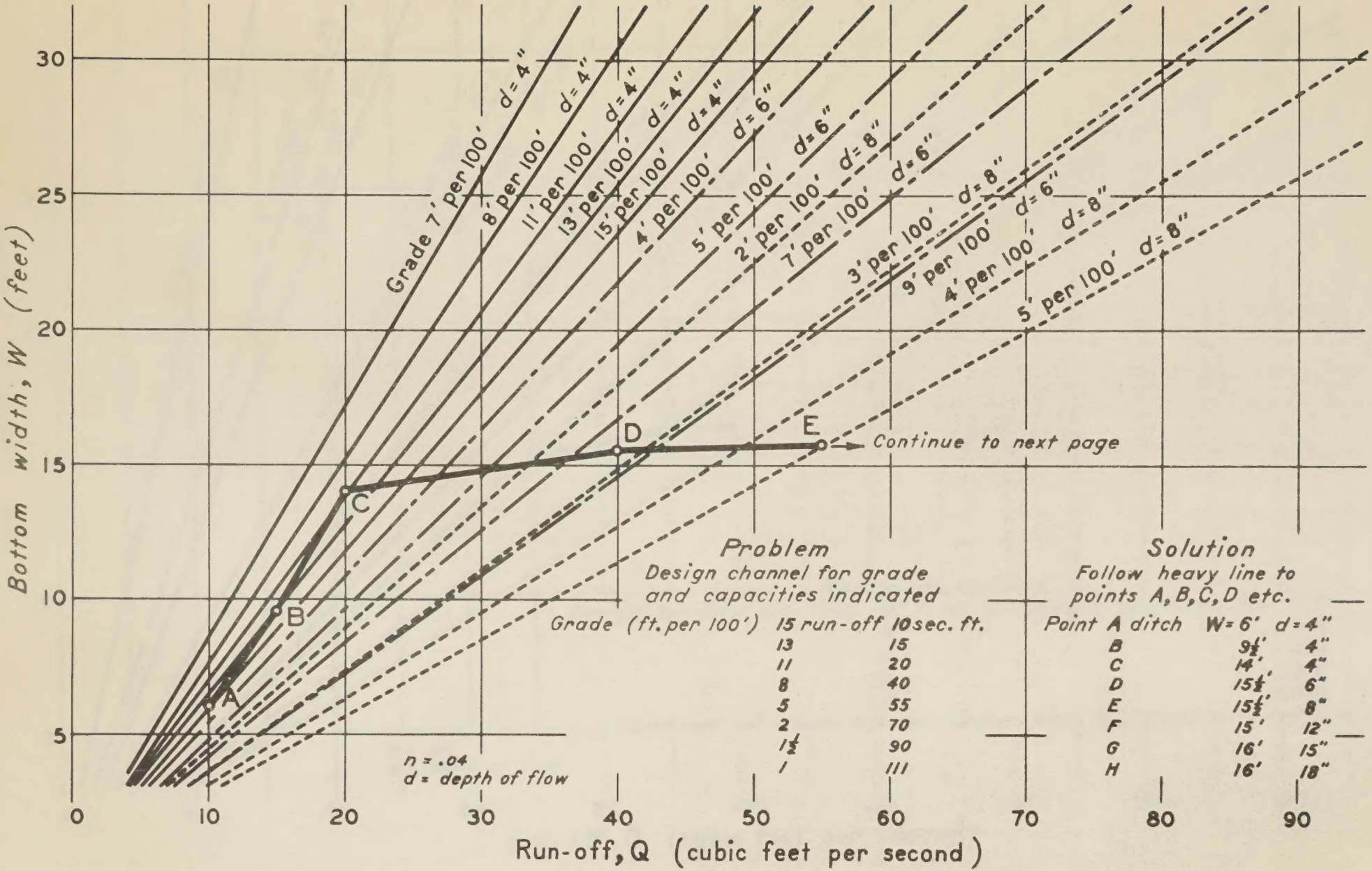
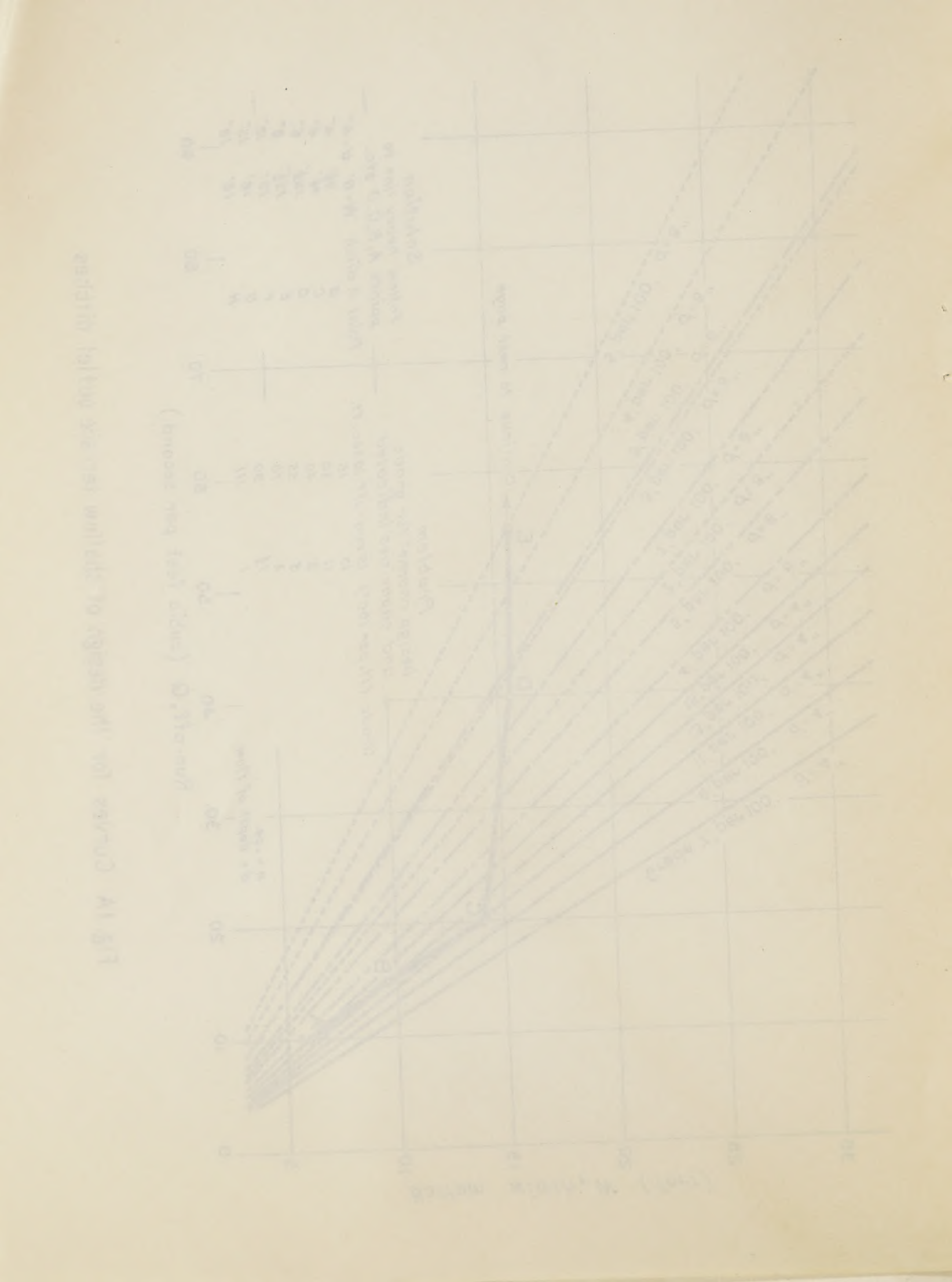


Fig. 1A Curves for the design of shallow terrace outlet ditches



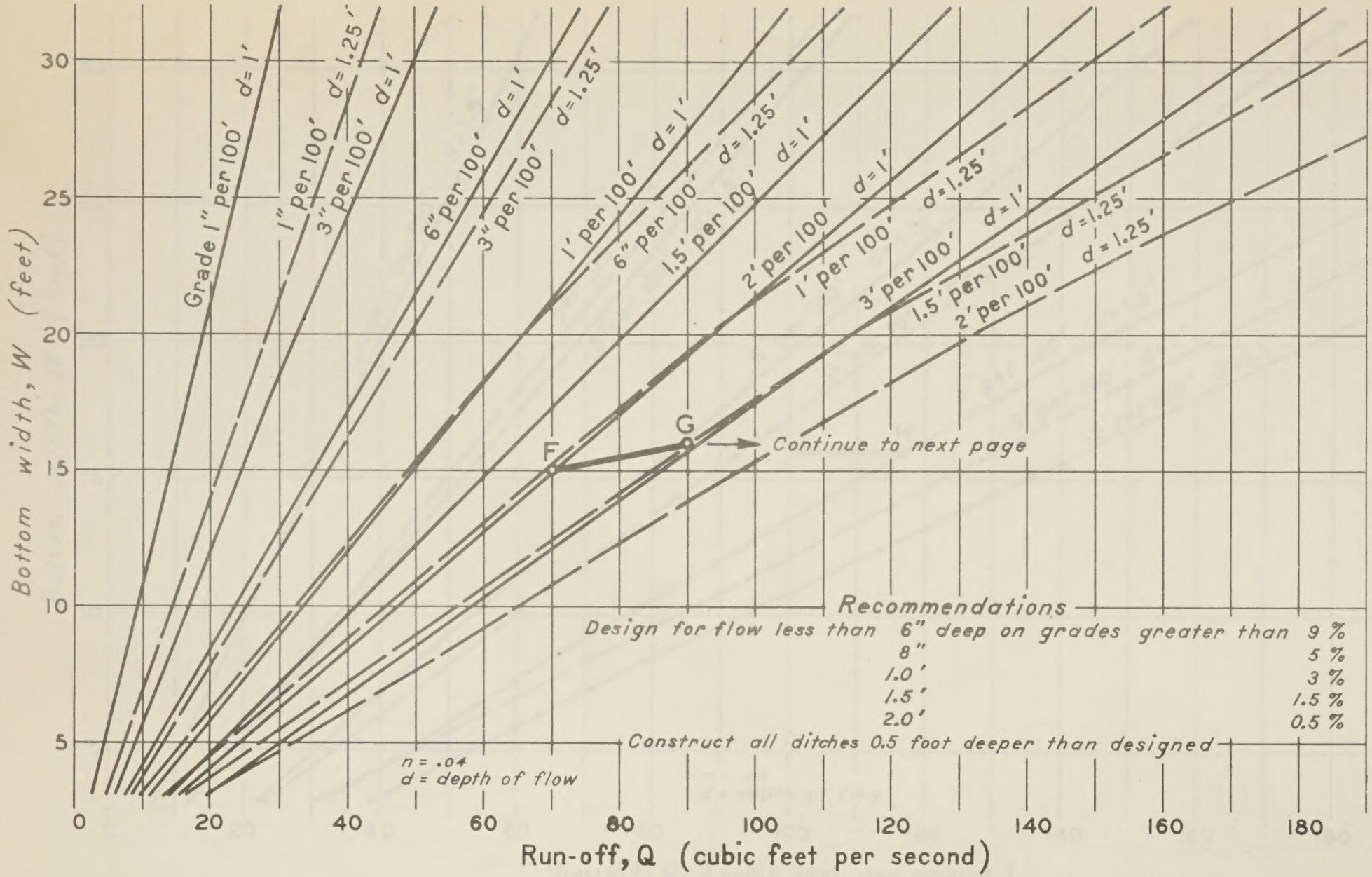
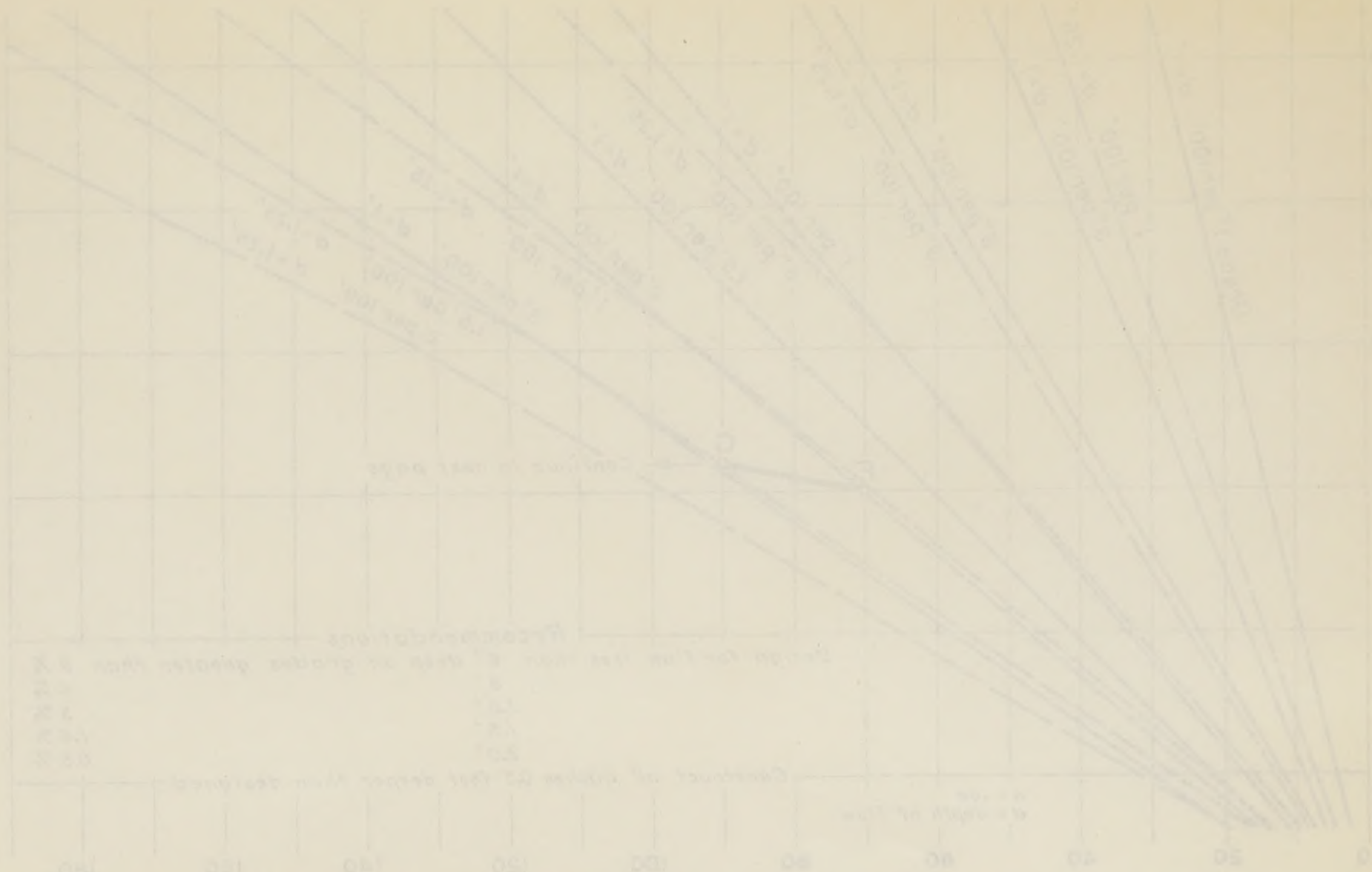


Fig. 1B Curves for the design of shallow terrace outlet ditches



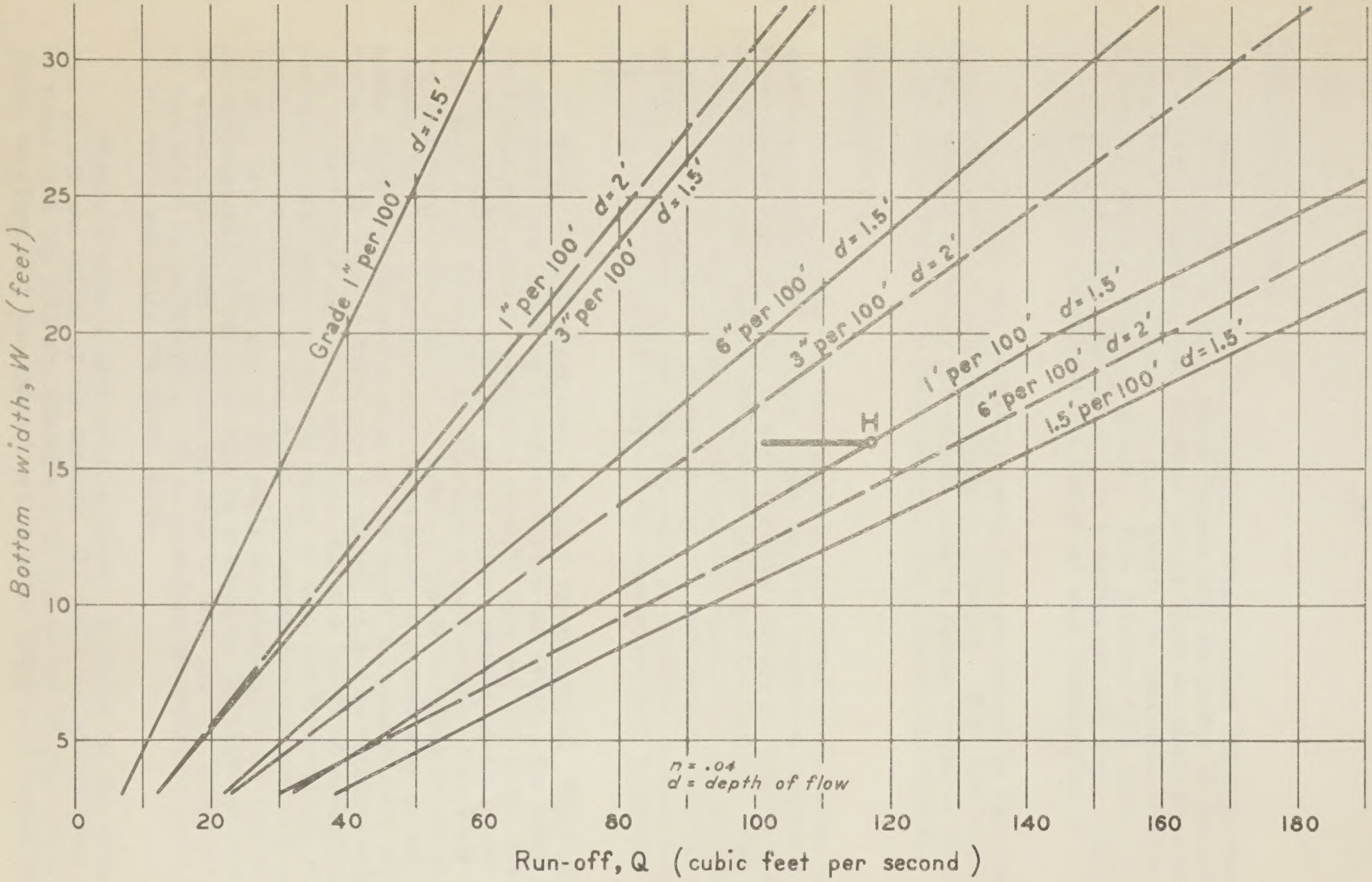
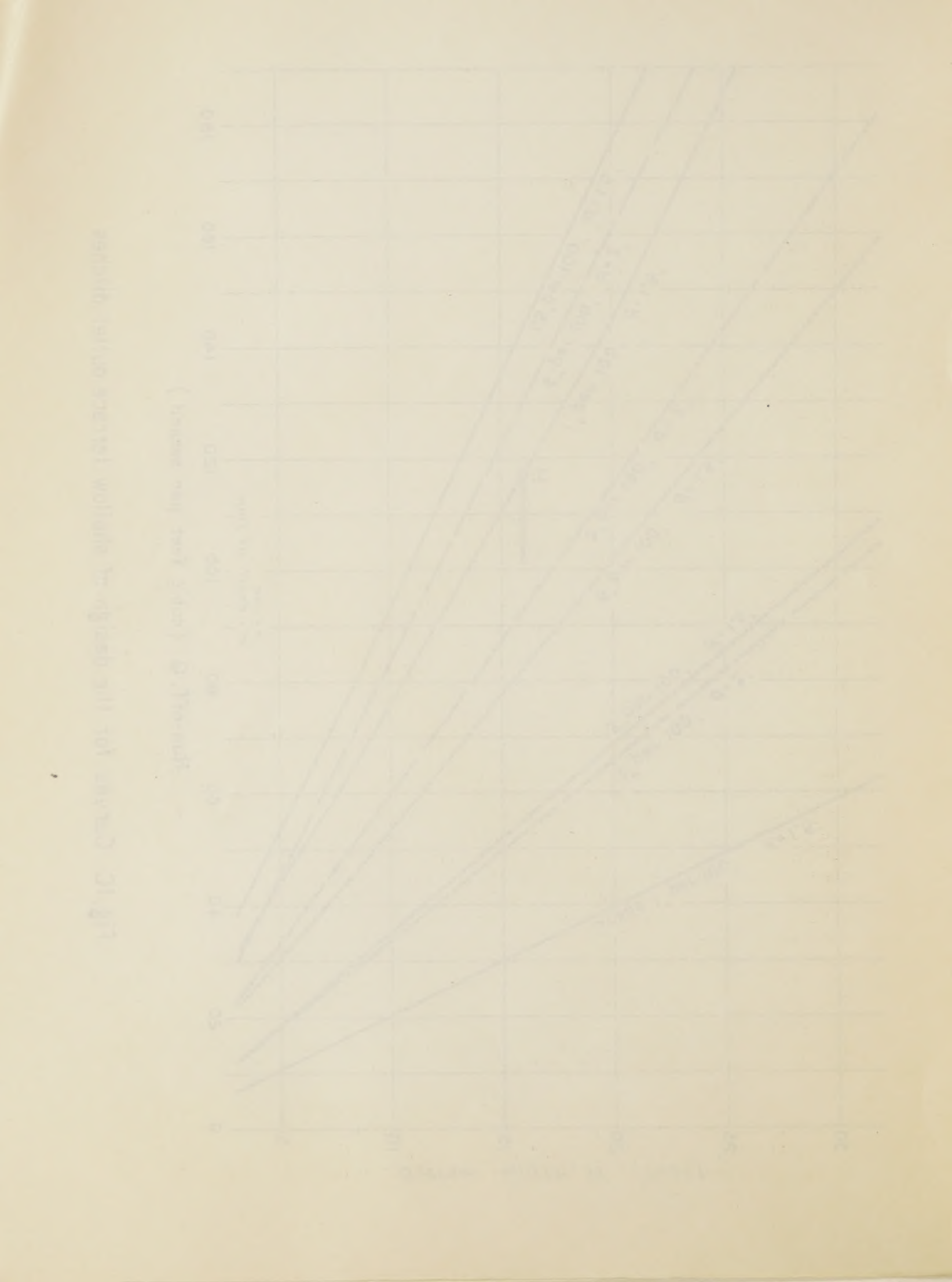


Fig. 1C Curves for the design of shallow terrace outlet ditches



Intercepting Ditches.

Aside from its use in designing terrace outlet channels where vegetative control is used, these figures will be useful in designing intercepting channels above terraced fields where an excessive area drains onto the top terrace. It will usually be desirable to have these ditches,parallel to the top terrace. This practice will limit channels to non-erosive grades usually of 2 to 4 inches per 100 feet. Figures 1B and 1C include curves for the design of such intercepting or diversion channels.

By dividing the run-off in cubic feet per second by the channel area the velocity in feet per second is obtained. When this velocity equals or exceeds 2 feet per second, erosion checks should be used to assist in establishing a grass cover in the intercepting channel.

Erosion Checks.

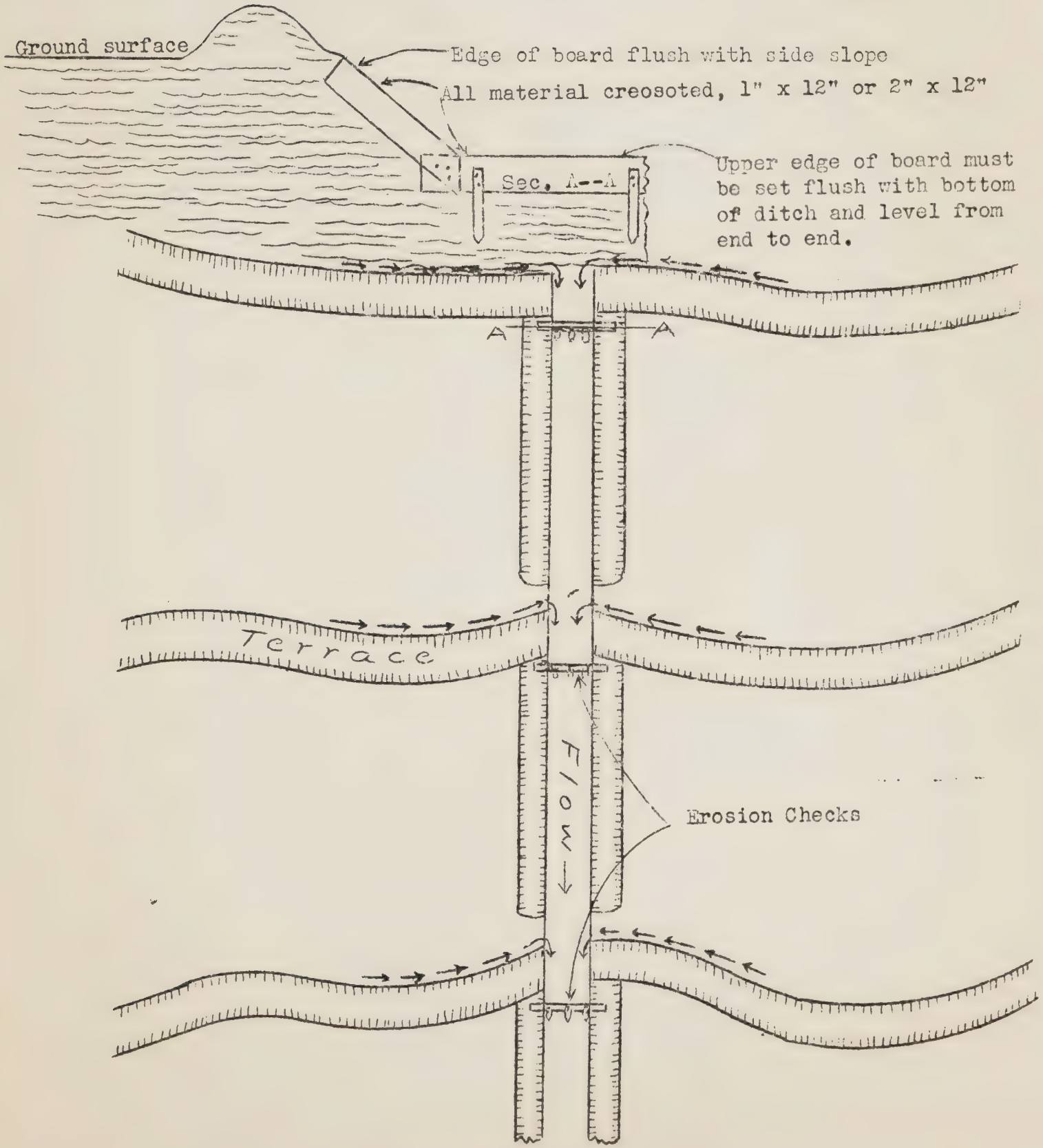
If terrace water is draining into the outlet ditch before vegetation is established, erosion checks must be located at intervals. These checks must be level to keep the water spread at uniform depth across the channel bottom and prevent small gullies forming. Spacing of these checks will depend on difficulties encountered in establishing a growth of vegetation. Ordinarily two for each terrace interval will suffice for moderate slopes and more will be required on steep slopes, depending upon the effectiveness of the vegetation used to prevent erosion.

Figure 2 shows plank erosion check installations. Upper edges of planks are set flush with channel bottom and sides. The plank across the bottom must have a reasonably straight edge and set level from end to end. In semi-arid sections and in those channels having a very poor soil where it is difficult to establish a good growth of vegetation the poultry-wire check shown in Figure 3 should be added to the plank checks. In this construction a strip 1-1/2 to 2 feet wide is well spaded along the downstream side of the board and planted with seed or roots. If the soil is quite poor it should either be replaced with top soil or fertilizer should be applied. About 2 inches of soil should be removed to make space on top for straw so that the finished job will be flush with the bottom of the ditch. The straw is held down with poultry wire laid over the top of the strip and stapled to the tops of stakes. The upstream edge of the wire will be stapled to the board erosion check. The straw will retain moisture and help to hold the soil until a growth of vegetation is established. It is sometimes advisable to place a strip of sod above and below the plank check.

Figure 4 shows a sack erosion check. A trench is dug across the side slopes and bottom of the channel, and sacks containing grass seed or roots with top soil are placed end to end in the trench. Tops of bags should be flush with the channel bottom after being well tamped and the

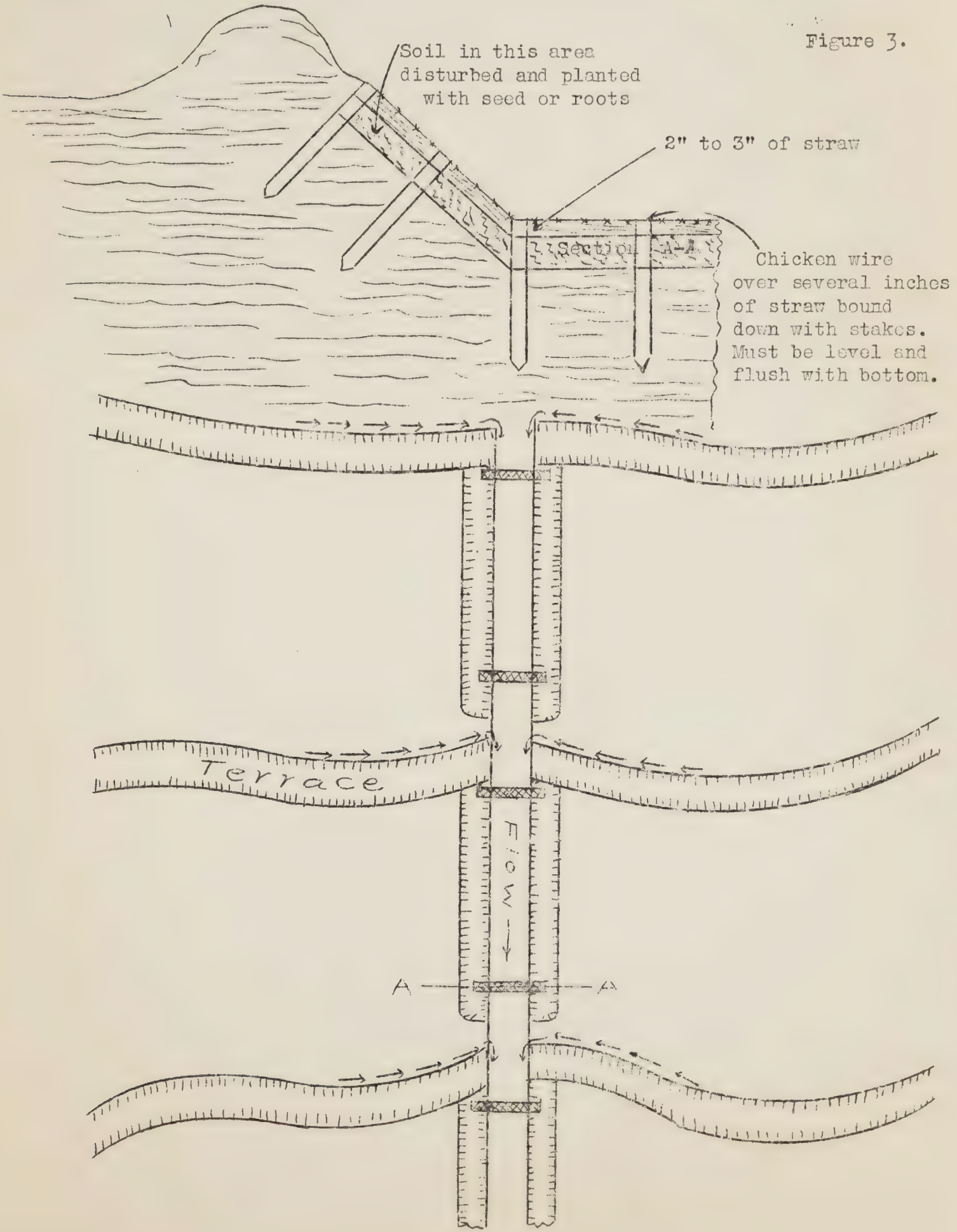
SKETCH SHOWING BOARD EROSION CHECKS INSTALLED

Figure 2.



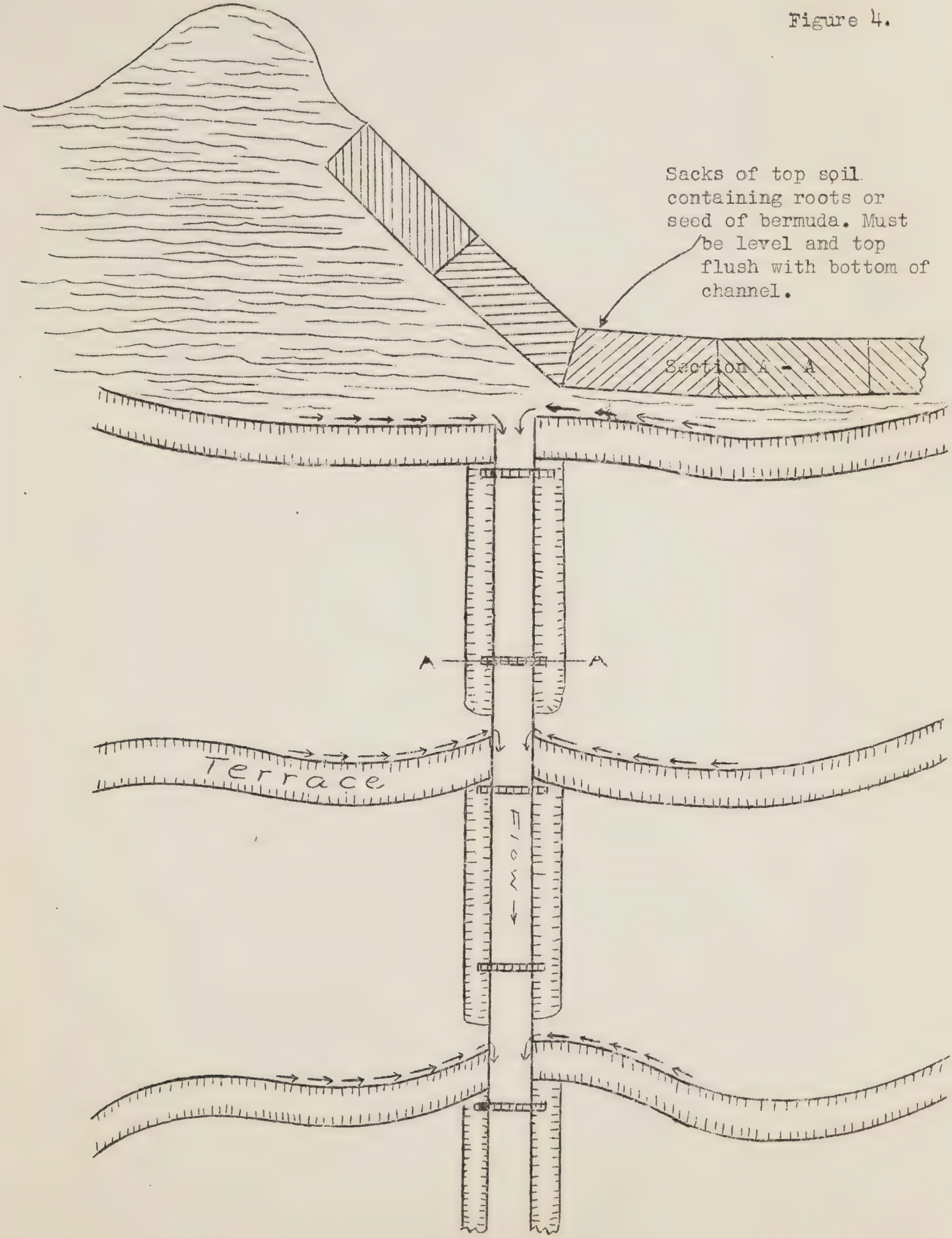
SKETCH SHOWING VEGETATIVE CHECKS ESTABLISHED WITH STRAW AND WIRE COVER

Figure 3.



SKETCH SHOWING SACK EROSION CHECKS INSTALLED

Figure 4.



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crest of the sack check should be level from end to end across the bottom of the ditch. If sacks are not filled too full ends can be flattened or squared up so as to leave no small depression where bags join.

The erosion checks shown in Figures 3 and 4 are very temporary and should be used only to supplement the more permanent work where the plank checks are used.

The area between checks can be vegetated by either seeding or sparsely sodding. To give temporary protection it will be found advantageous to sow oats or wheat in the channel.

Where no Checks are Needed.

If a temporary outlet can be used while establishing a vegetative cover in the channel, no erosion checks will be needed provided a satisfactory grass cover can be established. Figure 5 shows how this may be accomplished. The channel can be constructed in sections between terrace ridges and the terrace ridges cut at a later date, after the vegetative cover is well established, so as to discharge into the new outlet. There will remain only a section of channel at each terrace ridge (equal in length to terrace base width) that is not vegetated. It may be necessary to place a check in each of these sections when the water is turned in, depending upon the soil and climate and perhaps the vegetation used.

It is realized that completion of this type project will take some time and probably camps will not occupy areas long enough to see the jobs finished. Because of this, any such jobs undertaken should be thoroughly discussed with county agents and the State Extension Engineer so they can follow up and supervise completion. If the farmer goes to the expense of constructing the channel, it is reasonably certain that he will complete the job if contacted later and the work properly supervised.

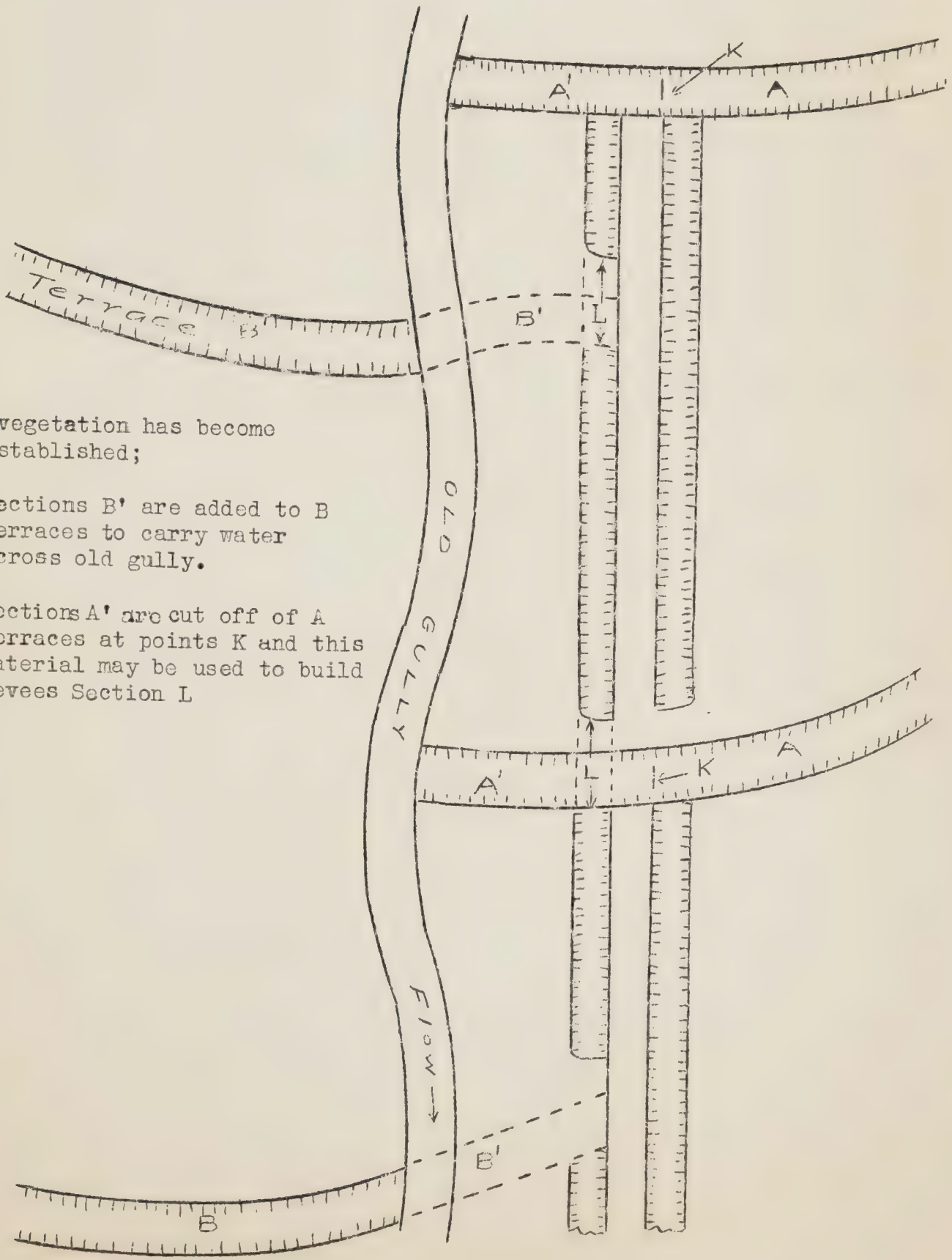
Extension agents should be familiarized with all vegetative control projects and supplied with plans and descriptions of locations. They can undoubtedly assist the camp programs with follow-up work on these projects.

Construction and Maintenance.

When constructed, these ditches should be about 6 inches deeper than is required to give the necessary capacity. This is to minimize maintenance needs in the immediate future. It is believed most satisfactory results will be obtained by constructing the bottom of the channel about one foot below the terrace channel, but when computing capacity, assuming the bottom of the ditch to be only 6 inches below the terrace channel grade. After the channel has filled to such an extent that the terraces do not properly drain, the best maintenance practice will be to turn ends of terraces down hill so that they will drain. This practice should be followed rather than working plows and scrapers in the ditch and destroying the vegetative cover. Where this practice is followed it may be necessary to build up levees slightly to conform to increased

VEGETATING DITCH WITHOUT CHECKS

Figure 5.



After vegetation has become well established;

(1) Sections B' are added to B terraces to carry water across old gully.

(2) Sections A' are cut off of A terraces at points K and this material may be used to build levees Section L

terrace heights; heights increased at the lower ends when they are turned down hill. This information should be passed on to farmers using vegetative control.

Vegetation Use.

In terrace outlet channels, or other channels that are of about the proper cross-section, no trees, brush, cane or vines, such as Kudzu, should be planted, but only grasses which will cause little obstruction to flow should be used. These grasses should be perennials with extensive root systems having good soil-binding qualities.

The best source of information for each camp should be the college extension agents and the agronomy departments of the state colleges. Local experience in the community is almost essential to success in establishing growths of the best available grasses.

Probably Bermuda grass would be best in every camp in this district. However, where farmers object to using it, some other grass must be substituted.

Centipede and carpet grass are both very desirable substitutes for Bermuda and seed for both of these can be purchased. Carpet grass may not survive in the semi-arid climates of western Texas and Oklahoma, but centipede grass should do well in those climates. Buffalo grass and wire grass should also be desirable for the western climates.

Johnson grass and lespedeza sericea both give too rank a growth. These should not be planted unless the ditch is part of a hay meadow where the grass will be cut regularly before it reaches a high, woody stage.

Aside from the information that might be available through college departments, the following publications are mentioned:

"Texas Grasses" by W. A. Silveus; Printed by the Clegg Company of San Antonio, Texas.

"Plant Life of Alabama" by Chas. Mohr. Published July 1, 1901, by the U. S. Department of Agriculture.

"Plants of Mississippi." Bulletin No. 17, by E. N. Lowe, Director, Mississippi Geological Survey; printed by Hederman Bros., Jackson, Mississippi.

No text or catalog of grasses for Oklahoma has been found. That for Mississippi does not list many of the grasses desirable for erosion control work and it will be of little use to the camps. The most comprehensive work, and most valuable to the layman, is the book on Texas grasses. This should be very useful to Oklahoma as well as Texas camps.

Where to Use Vegetation.

Vegetation should be used to control erosion in the upper reaches of terrace outlet ditches on all projects. Usually that portion of the ditch serving the first two to five terraces, depending on the drainage area, at the upper end of the outlet can be controlled with vegetation. Permanent structures are then used in the channel below this section. In this plan the failure of a vegetative cover will not endanger the stability of structures. Vegetation may also be used on small projects where the use of permanent structures would be very costly. However, it should not be relied on to control erosion below a series of permanent structures; that is, unless the grade is so light that it is practically a non-erosive slope and a good cover of vegetation is assured. If there is any doubt as to whether the grade will erode, erosion checks should be installed.

Channels with vegetative control should not be used in lanes where live stock is driven to and from pasture or where farm implements are hauled to and from the fields. They should never be used inside of pastures adjacent to fence lines for barren stock paths are often formed along these lines. It would be advisable to locate all vegetative control projects outside of pastures for only in the event the pasture is very lightly grazed will these projects succeed in pasture locations.

By

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